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OF THE

BOARD OF HEALTH

OF THE

DISTRICT OF COLUMBIA,

ON THE MATTER OF THE

IMPROVEMENT OF THE SEWERAGE OF WASHINGTON.

[On the 17th of May, 1878, the clerk of the Senate Committee on the District of Columbia addressed to the Board of Health a note stating that he was directed by that Committee to enclose copies of Senate bills 1216 and 1248, relating (1) to the improvement of the sanitary condition of Washington by deepening the river channel, and (2) to improve the sewerage of the city; and stating, also, that the Committee desired the Board to furnish them all possible information relative to the existing system of sewerage, and suggestions in regard to its improvement.

Such proceedings were thereupon had that at a meeting held on the 6th day of June, 1878, a special committee, consisting of Messrs. Warden, Verdi, and Bliss, having been appointed at a former meeting to draw up a proper answer to the said communication, reported, recommending that the answer be the following; and the said report was unanimously adopted.]

REPORT.

To the Honorable the Senate Committee on the District of Columbia:

GENTLEMEN: Your communication of the 17th ultimo has received careful attention. So far as it relates to sewerage we now respond to it as follows:

The sewerage of this District has, for a long time, been matter of very great concern to the Board, notwithstanding its imperfect powers; but, since the reception of the communication just referred to, the Board has taken various measures to acquaint itself more thoroughly with the whole subject.

There can be no reasonable question that the existing system of sewerage is not at all adequate. It very greatly needs improvement.

Plans for its improvement have been laid before the Board. These have been carefully and patiently considered and compared with other projects.

Our considerations have not overlooked the theories of sanitary engineers who have contributed to the literature of the subject; but we have endeavored to give no more than due respect to what we find in books in relation to sewerage. It is important to attend sufficiently to the theories of writers; but it is important also not to be too greatly influenced thereby.

In one of the communications made to us we find the suggestion, in effect, that, to remedy an evil pointed out in that communication, it is necessary to command the assent of nature.

This is true enough; but it is proper to assure ourselves that though, without the assent of nature, art is always powerless for good, there is no reason for attributing to nature a disposition to reject the modest help of

art. The sanitary engineer ought not to have to learn, that art and nature are not out of harmony when art sufficiently considers, and respects, and faithfully endeavors to assist, the works and ways of nature.

The communication we have mentioned also says that the plan it offers proposes to solve an indicated problem as nature has always done it under similar circumstances. We must, however, bear in mind the almost infinite diversity of what may be distinguished as physique and physical conditions in the places where the work of sewerage is to be performed.

In all that we shall say in this communication we shall constantly keep in view the extremely marked peculiarity of physique and physical conditions in the city which is chiefly interested in the subject of this paper. We shall not attempt to apply to Washington ideas which, however applicable elsewhere, have no proper application here.

It is convenient to refer to the following language put by the president of this Board into one of his reports :

"The city of Washington is located on an area in the shape of a basin, having for its rim a circling range of low wooded hills, the highest point of this basin not being over forty feet above the surface of the great river Potomac. It is, therefore, with difficulty that it is drained; and, for the same reason, it is exposed to periodical freshets during the rainy seasons of spring and fall. Its shallowness is also the cause of many ponds of stagnant water."

In another part of the same report Dr. Verdi says :

"Washington, of old, was but a quagmire in winter and a sandy desert in summer. Washington, reclaimed, is anything but perfect."

Major Randolph, in an extremely interesting communication to the Board, expresses some of his ideas in this fashion :

"There is scarcely a city or town, situated upon tide-water, that does not find itself confronted with the difficulty of getting rid of the effete products of its population after it has descended to the general level of the ocean; for few of them are located upon the slopes of hills whose bases are washed by the constantly-outward flow of a large body of pure water. The city of Georgetown is, doubtless, attended with these favorable conditions to as great an extent as any city in the world. The whole of its sewage can be rapidly discharged into the deep channel of the Potomac, which, although subject to the oscillations of the tidal wave, is filled with the constantly-passing volume of the drainage of an immense area of back-country. But the city of Washington is built upon a broad and slightly-elevated plateau, confronted by what was formerly a tidal marsh and a large area, formerly called the Island, sloping gently from the river towards the rest of the city; while the river itself presents a wide extent of shallow flats between the land and the vital current of its waters.

"Under such circumstances, the force of gravitation at the disposition of the engineer is entirely insufficient to propel the sewage along the distances involved in reaching the proper points of discharge. It is fortunate, however, that the difficulty can be entirely overcome by the application of artificial power."

It is in the presence of so sharp contrasts as the contrast between the topography of Georgetown and the topography of the adjacent capital of the United States that the great principles of sanitary engineering, as an art and a science, are most strikingly apparent. These great principles discern completely the alternate conflict and harmony of the works and ways of nature with the works and ways of art.

Another part of Major Randolph's carefully-considered communication runs as follows :

"Objection has lately been made by an authority in engineering to the direction in which I have proposed to propel the tide-locked sewage along B street, on the ground that it was forcing it up-hill, and contending against nature. But the only thing which was stated to determine the direction of up-hill was the fact that the bottom of the B-street sewer is about two feet lower at Seventeenth street than at Seventh street, and which was considered a descent of two feet to the mile, although lying below tide-level. The same objection applies to the Potomac river itself; for, at Easby's

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wharf the bottom is twenty feet lower than it is at the deepest part, opposite to Sycamore Point, one mile lower down the river, being ten times the inclination of the B-street sewer. Yet the same engineer would not insist that the Potomac runs up-hill. But forcing water up-hill is rather an imitation of nature, who forces water up-hill into the clouds, in order that it may be transported to the sources of our rivers, and flow to a distance."

Not precisely on the ground so pointed out, but for reasons which appear to us unquestionably solid, we conceive that the exception here in question is not fatal to the plan to which it is opposed.

Another exception to the same plan is that it is opposed to the principle that it is better to *draw* than to *drive* water. This exception we consider as too broad. Of course there may be conditions in which it is better to drive than to draw a stream; and the practical question is, whether the conditions here in question are such as to give a proper preference to the *drawing* process or to dictate preference of the *driving* process.

It is also said to be a principle never to resort to artificial means where natural means are adequate. But, as already intimated, we consider that art and nature are appointed to work together; and that, even where natural means are barely adequate, artificial means may serve a better purpose in the circumstances. At the same time we fully recognize the principle that art is always bound to take the due advantage of nature.

No one here proposes to rely on natural means alone. The simplest plan proposed makes large resort to artificial means and measures.

It is well suggested in Latham's valuable work on *Sanitary Engineering* that "when the natural drainage area of the District has been well defined, it will be well to ascertain what nature has done for the drainage, and also what has already been done by art in the way of accomplishing the work of sewerage of the District." *

We have not neglected this eminently practical suggestion in the least; but we have shown already that the physique and physical conditions of Washington are very markedly peculiar. They are partly due to nature, partly due to art; and neither art nor nature seems here to have done its finest work.

In the already cited report of Dr. Verdi stand the following words relating to our sewerage:

"The Board of Public Works instituted a grand and comprehensive system; one that should reach every household in the District; and this probably was its first mistake; for the work so organized was so extensive as to be liable to the imperfections that are so glaring now; and its sewer system is one that did not escape the confusion of hurriedness. The rapidity with which that work was carried on did not permit of that mature reflection necessary to secure the construction of a perfect work. In many instances, therefore, these sewers are inadequate in size, faulty in construction, wrong in conception. Where inadequate in size, they overflow at the fall of every heavy rain; where faulty in construction, they give way under pressure; where wrong in conception, they are a source of positive evil."

Dr. Verdi did not fail to connect with this language clear indication, that he took into consideration all the difficulties and embarrassments of the authorities who had charge of the work in question. And it is important constantly to bear in mind the great diversity of opinion as to what should even now be done with a view to make the sewerage in question what it ought to be.

Among the communications we have received is one from Mr. Edward Chesley, who appears to have devoted much attention to the subject.

He remarks, in substance, that we have sometimes to deal with a torrent which cannot get away fast enough, and sometimes with a sluggish stream of

dirty water which cannot get away at all; that to get over the first part of this evil we have dug the discharge ends of the sewers below tide water; and that to remedy this evil in a way to command the assent of nature is the problem.

Thereupon, he proposes alteration and extension in this way:

"First, at any point as near the outlet as possible, where we can get a descent of 10 feet in the 100, we will, near the top of the descent, divide the main sewer into two, having a combined area a little less than the main sewer—since a rapid current will compensate for less area and greater friction—we will place one to coincide at the top, the other at the bottom of the large sewer, in order that, in the ordinary flow, the lower one will receive the entire sewerage—thus concentrating the current, and leaving the other dry.

"As we approach the foot of the hill we will subdivide—making four small sewers, with a combined capacity a little *greater* than the single one above—to compensate for greater friction, and a more sluggish flow.

"Three of these small ones will coincide with the two larger at the top; the fourth with the bottom of the one that receives the water from the large one, which will still further concentrate the current in the *one* small sewer, thus giving it a more rapid flow, which will enable it to keep its course free, while the other three remain dry.

"On leaving the descent they all come to the same grade, and as near the surface as possible.

"It will be seen that three of these sewers are reserved in case of a flood, which is comparatively pure water, and rapidly runs off, leaving the sewer dry and clean to act as a ventilator—the sewer, which is in constant use, being *lower at its head*, of course receives the greater quantity of water, and, consequently, a more thorough washing at each rainfall.

"In this way we manage the small but deadly stream, and provide for and utilize the torrent, avoiding entirely the necessity of digging below tide-water.

"This is made clear by tracing the large sewer to its outlet. The top of the sewers all being on the same grade, of course any enlargement must be downward, and, consequently, below tide-water.

"This plan I claim to be natural and, consequently, permanent, (for we must look to our needs a half century hence,) since nature has used this plan to get successfully over similar obstacles at the mouth of the Mississippi, the Nile, the Danube, the Ganges, and other places, since the world began.

"The expense of this plan is not necessarily excessive, since the four small sewers can be constructed for little, if any greater expense than the one large one; for once done the expense ends.

"This plan, in connection with a sewer-gas trap, which I now submit, seems to me to offer the solution sought for this great sanitary problem.

"This trap has a fall of at least forty-five inches from where it enters the opening to the bottom, and a rise of nineteen-and-a-half inches to the opening of the sewer, with a round smooth bottom, favorable to freedom from mud by the fall of the water, and does not depend on the top plate for its efficiency, as said plate is always loose, and often broken."

The next plan we propose to notice is that presented by Mr. W. D. Hughes.

This gentleman presents the plan of a sewer from Centre Market to the Potomac on the line of Eighth street, connecting with the canal sewer. This, it is said, would afford a direct and rapid outlet for the drainage of the city. The projector considers that it would have ample fall. He points out that the fall, which is now distributed upon two miles and a half, could be concentrated upon three-quarters of a mile. Attention is invited to the fact that in addition to the long circuit which the water has to travel, the fall, little as it is, is not equally distributed. It is said that from Sixth street to Seventeenth street there is not any fall, but just the contrary; and that, therefore, while the Potomac runs actively, the drainage is not benefited by its activity, as there is no fall in the sewer to carry the water to the river. Mr. Hughes explains that the proposed sewer would be different; that the entire fall from B street north to the Potomac, at Eighth street, would be utilized by a uniform grade, and there would be ample drainage; that the proposed sewer would drain rapidly; that it would not only have ample

fall to wash itself, but it would empty the canal sewer and its tributaries. Thus, says Mr. Hughes, the canal sewer would be utilized. It would no longer be charged with stagnant water and indescribable impurities, and the property upon its line would have the advantages of active drainage.

It is next explained that by opening the proposed lock on the mouth of the canal sewer at Seventeenth street at the outgoing of the tide, or at other periods, a stream from the Potomac would make a circuit of the sewers and return to the river at Eighth street. This, we are told, could be done in times of droughts, or at other periods when it would be deemed necessary to give the sewers a special washing out; indeed, it might be let flow steadily, provided a freshet was not anticipated.

Mr. Hughes says:

"The water would have the same flow through the sewers that it has in the river. The Potomac would be the source and the river would be the emptying point. The water would flow with the same force by either circuit; it would only be a diversion of the water of the Potomac. Consider this; compare it with the present sluggish and stagnant sewerage! As a sanitary measure, it would be above price. In order to guard against high tides, it would be commendable to have a gate on the mouth of the contemplated sewer, and also on the eastern mouth of the canal sewer. These gates could be so constructed as to be self-opening and closing. The expense of constructing them would be small. Should the water rise in the Potomac, whether by tide or freshet, the gates would close by the action of the water, and prevent its flow into the city; and the moment the water in the river would subside, the gates would open by the pressure of the water in the sewers. Apart from freshets, it would be well to keep the tide from entering the sewers. The tides—varying as they do from two and a half to nearly five feet—are freshets upon a small scale. They drive sewer-gas into all the buildings in the city. They also force the impure matter in the sewers into the city. Experience has demonstrated that the flow of water caused by local rains, no matter how heavy, had uniformly subsided many hours before the rise in the Potomac, as it takes considerable time for the mountain waters which swell the river to reach this city. When the gates would close by tide or freshet, the sewers would have ample capacity to hold the drainage for the time being; in no case could the water within rise higher than the water outside the gates. The gates would be positive preventives to the flow of back water; therefore the hurtful filth heretofore described could *not* be driven into the city, its houses, stores, or streets; nor could *debris* from the river enter the sewers. In times of freshets there is an excessive pressure upon the sewers at the Botanical Garden, where the Tiber-creek and the canal sewers meet. So great is the pressure that the sewers are liable to burst at any time, to the great danger of the surrounding property. The sewer which I suggest would relieve the pressure mentioned."

In a subsequent communication Mr. Hughes proposes a plan by which, he says, "the drainage of the city of Washington can be successfully accomplished by artificial means, by a combination of water-power and steam-power." That new plan is noticed in another part of this paper.

We have also received a communication from Mr. Benjamin Severson. That gentleman explains that he has before the Senate Committee on the District of Columbia what he supposes to be a complete plan for draining and sewerage the canal and Tiber valleys, and for the improvement of the Potomac river, showing also the intimate relations between these highly important matters; but of this plan he regrets that he cannot give the Board a copy. He explains, however, that that plan is for intercepting all the sewage reaching the valleys named, turning their flow eastward, and discharging them through the mouth of the Eastern Branch into the deep water of the Potomac, south of the Arsenal; their flow being aided by the waste-water of Rock Creek and by a large volume of tide-water, so admitted at the foot of Seventeenth street as to insure a constant flow through the sewer in but one direction. He remarks that this plan is very simple, and that he believes it to be the best and most economical that has been or can be devised; but that it or any other complete plan would require considerable time for its execution, while the condition of the present sewer is so

exceedingly offensive as to call for immediate relief. He therefore recommends the earliest possible execution of what he calls the first part, or work required for carrying out the plan at large, viz: the connection of Missouri avenue with the B-street sewer at Seventh street, and the causing of a large flow of tide-water through them, the flow to be but in one direction from Seventeenth street to the Potomac, south of the Arsenal. He points out that thus the flats, or any part of the river-front of the city, will be prevented from being befouled by the discharge of vile sewage upon them, and the sewage being thus promptly removed from the sewers by the large flow of comparatively pure water through them, there will be no time for the sewage to ferment and generate noxious gases, as they do at present.

Mr. Severson explains that the heaviest part of the work so proposed will be the extension of the Missouri-avenue sewer—having a sectional area of twenty-six square feet—some seven hundred feet in length westward, and the connection of it with the B-street sewer at Seventh street. This, he suggests, may be done by contract, as it can be specifically described. He says that the other work, mainly at the western end, being more irregular, and consisting of excavation, dredging, and the formation of wooden trunks and tide-valves, all of a temporary character, to last only till a full and permanent plan can be carried out, plans for these parts cannot well be made without a survey, and therefore might be done by day's work, under faithful superintendence.

As to the cost of this first part of the plan, Mr. Severson says that it need not exceed fifteen thousand dollars. And he thinks that, with good management, it may be accomplished with a somewhat less sum and in six weeks time.

In the communication of Major Randolph to the Board appears this passage:

"It has been proposed to apply to the same general arrangement the feeble force which might be made available by enclosing a portion of the river water near Seventeenth street, at high tide, and to depend upon the current thus set up, twice in twenty-four hours, due to the slight and transient inequality of the level at Seventeenth street, and that of the Eastern Branch, a distance of three-and-a-half miles. By this means a small quantity of water might be passed to the south, and the sewage concentrated in Tiber Creek and the James Creek canal, there to become offensive; but the contents of the lateral branches having nearly reached the point of decomposition in their long transit from the upper parts of the city, would not be drawn off with the frequency and rapidity necessary to prevent the development of noxious gases in the neighborhood of Pennsylvania avenue. I think that so moderate an expenditure for steam-power as I have proposed should not be weighed in the balance against the health, or even the comfort, of the nation's Capital."

The plan to which this language draws attention is essentially "a method of so applying steam-power as," in the opinion of the proposer, "to counteract the evil effects consequent upon the unavoidable circumstances of the topography and hydrography of the site." According to Major Randolph, his plan "accomplishes two results: one, the excessive dilution, and the other, the prompt removal, of the sewage to the southern extreme of the city, and into the deep water of the channel, near the arsenal."

The communication under notice indicates the line of the old canal, extending from Seventeenth street to the eastern branch of the Potomac, near the arsenal, as the natural and the most economical location for a conduit to which steam-power may be applied: and the elevations of the city on each side of this line, when considered with the distances, are said to be barely sufficient to conduct the sewage, with the speed demanded by sanitary considerations, to the points where the artificial power is available.

Attention is called by Major Randolph to the fact that the outlet of the B-street sewer has a sectional area of one hundred and fifteen square feet;

that it is formed by a rectangle fifteen feet wide and five feet high, surmounted by a circular arc, whose versed sine is four feet; and that the bottom is placed five feet below mean high tide. It is proposed to enclose it with walls of water-tight masonry, with an opening of the same form and area, but situated eleven feet lower, the top of one being two feet lower than the bottom of the other. It is explained that if the plan now under notice be adopted and carried into effect, the water, before issuing from the lower outlet, will pass through a circular opening of twelve feet in diameter, and that within this circle a four-bladed propeller, somewhat of the form of a ship propeller, will revolve horizontally, with the shaft vertical, and that thus the water will be forced upward or downward as may be desired.

According to the views of the author of the plan in question, this arrangement leaves the discharging capacity of the sewer intact, while it places the propeller where it can lift the water from the level of extreme low tide; and when excessive rain-storms require the full discharging capacity of the main sewer, the revolution being reversed, all the power of the engine accelerates the discharge outward as originally designed, in effect largely increasing the capacity of that sewer.

It is claimed that during periods of hot and dry weather, when decomposition of the sewage would otherwise take place, the propeller will raise from extreme low tide to three feet above mean high tide, if desired, 5,500 cubic feet = 41,250 gallons = 343,750 lbs., per minute, or 7,920,000 cubic feet = 59,400,000 gallons = 494,000,000 lbs. = 221,000 tons of water per day of 24 hours. Attention is then directed to the fact that, according to the estimate of the board of survey for the improvement of the harbor of Washington and Georgetown, that portion of Washington of which the sewage discharges along B street receives twenty tons of solid contaminating matter every twenty-four hours; and three hundred times that weight of water, or 6,000 tons per day, is sufficient to so dilute the offensive matter as to render it inoffensive and innoxious. And, thereupon, it is suggested that, according to this authority, the sewage will be diluted nearly thirty-seven times more than is necessary.

It is important to remark that, according to Major Randolph, the Missouri-avenue sewer and its branches receive the benefit of the proposed arrangement, through connection at Sixth street with the B-street sewer at Seventh street.

By the plan, of which an outline is here sketched, the apparatus proposed to be placed at 17th street is relied upon to supply all the pure water necessary for an excessive dilution, and to add a volume to Tiber Creek or James Creek canal sufficient to cause a constant outward flow, carrying the sewage to the deep water of the river before it can become fetid. This apparatus, explains "the projector," "is to work periodically, so as to cause a frequent pulsation and renovation in the whole system of depressed sewers independently of the stage of the tide."

It will be observed that the plan provides for engines, with double boilers and cylinders, protected by brick houses with fire-proof roofs, and resting on solid foundations; and that gates are provided on each side of the apparatus, so as to shut out the water and to pump out the enclosure when it may be necessary to repair or replace any part of it.

According to the views of Major Randolph, when that very obvious improvement is carried out of connecting the high ground about the Monument with that near 19th street, by raising Virginia avenue above the flood-line of the Potomac, thus preventing its encroachment on the city, the propeller at 17th street will discharge all the sewage and a considerable rain-fall in addition, notwithstanding the flood, it being of no consequence, at such

times, in which direction the sewage is discharged. He points out that the coincidence of extraordinary rain-storms in the city with high floods in the Potomac is of very rare occurrence, generally the rains producing the floods having subsided before the swollen volume of the river reaches Washington; and that when such coincidence does occur, the injurious results, if not prevented, will be mitigated by the action of this engine, as well as by that of another engine to be located about 9th street, and propelling the water in the other direction.

Major Randolph also submits that by filling all the sewers to the maximum elevation—which act is accompanied with a very slow current—and then reversing the revolutions during the stages of low tide, a rapid current will be created, due to the previously accumulated head, combined with the action of the propeller, and that by this means most of the sediment that may have been deposited may be removed. He explains that this operation can be carried on in cold weather, when it is unimportant in which direction the discharge is made.

Another of his explanations is that, after each filling of the system with pure water, the engine at 17th street will propel only to the extent of preventing an outward flow, while the engine at 9th street will empty the system and force the contents of contaminated water through a circular conduit, to be constructed along the most direct line available, into the large culvert provided for Tiber Creek. The proposed diameter of the conduit is five feet, with an area of twenty square feet. The propeller is to be about five feet in diameter, and to be worked in the same way and with similar arrangements as that at 17th street, the latter being of such greater diameter only for the purpose of affording the same discharging capacity as the outlet of the main sewer has at present. According to the projector, it will have the same elevating power, and will raise the water from low tide and maintain a constant head of six feet in the conduit three thousand feet long, causing it to flow with a velocity of 275 feet per minute, or $3\frac{1}{4}$ miles per hour. The calculated quantity of water is 59,400,000 gallons in 24 hours.

The plan proposes a 100-horse power engine at each point, one-horse power being that which will raise 33,000 pounds one foot high in one minute, or 5,500 pounds six feet high in one minute. It is said that as the engine must raise 343,750 pounds six feet high per minute, the horse-power required for the work is 62.5; and as not more than 25 per cent. of this power will be lost in the machinery itself, there will be applied 75-horse power, which is an excess.

Remarking that the consumption of fuel by steam-engines depends upon their quality and their management, those of the best quality, properly managed, consuming only $2\frac{1}{2}$ pounds of coal per hour for each horse-power, Major Randolph explains that one of these engines of 100-horse power will consume 225 pounds of coal per hour, and, supposing it to run day and night, the consumption will be 5,400 pounds, or about $2\frac{1}{2}$ tons per day, worth about \$10. It is further estimated that for attendance would be required, one engineer, at \$3, and one fireman, at \$1.50—\$4.50 per day. If the engine should be run all night this expense would be doubled, making \$9 per day. But it is said that there will be no necessity for the operating of the engine except during dry and warm weather.

Mr. Chesley says:

"The proposition to employ steam-power in connection with tide-locks seems but an inadequate remedy for the evils of that system, with its own additional objection of augmenting those disadvantages, and great and continued expense."

Mr. Severson has informed the Board that he considers the plan of Major Randolph exceptionable.

Mr. Hughes says :

"The induction of water into the B-street sewer by steam-power or by dam would raise the water in the sewer and therefore would impede the action of the great number of sewers which are tributary to the B-street sewer. Besides, the raising of the water in the sewer would force sewer-gas into the houses. The lowering of the water in the B-street sewer is what is needed. It would remove the pressure which forces sewer-gas into the houses and the streets.

"Should the employment of steam-power be deemed advisable, the better way to utilize it would be to extend the B-street sewer to a remote point on the Potomac, and there construct a basin, say fifteen or twenty feet deep, and of ample capacity. This would form a receptacle for the sewage. By the aid of pumps the basin could be kept nearly empty. The vacuum would cause water from the Potomac to flow actively through the B-street sewer to the basin. It is better to draw than to drive water. By drawing it it would be lowered, while by driving it it would be heightened. The heightening of the water in the B-street sewer would be an impediment to the drainage. Your object is not to impede the drainage; what you seek to accomplish is the improvement of the drainage.

"To make the basin twenty feet deep and keep it empty would be equivalent to lowering the Potomac twenty feet, so far as the drainage of the city is concerned. The basin constructed as suggested, a sewer could be built the bed of which could be sufficiently low—not less than three feet lower than the bed of the present B-street sewer—to perfect the drainage of the city for all time, and the raising of Pennsylvania avenue and other futile notions would be abandoned. Steam-power could thus be used advantageously, but it is better to exhaust all other means before incurring the perpetual expense which steam-power, and its use day and night, would incur.

"The proposed injection of water into the B-street sewer, by steam-power or by a dam, would be hurtful. Instead of washing the foul matter out of the sewer, it would stir it up, and therefore would add to its hurtful tendencies, and would force sewer-gas and other offensive and poisonous odors into the houses and streets of the city."

In a subsequent communication, Mr. Hughes says that the proposed injection of water into the B-street sewer, as suggested by Messrs. Severson and Randolph, would be hurtful; that it would stir up a stench, instead of washing the foul matter of the sewer; that it would be pestilential in its workings; that it would poison the atmosphere of the entire city, by forcing sewer-gas and other offensive and poisonous odors into the houses and the streets.

On the other hand, a wholly disinterested expert, Lieut. Hoxie, civil engineer of the District, being interrogated in open session of the Board, pronounced the plan of Major Randolph feasible, and expressed the judgment that it will accomplish all that it proposes; while of the Severson plan he said that, until he saw it demonstrated, he should doubt its adequacy.

This opinion seems to us entitled to great weight.

But it is necessary further to notice that Mr. Hughes has presented another plan—the plan already mentioned as considered by the proposer adequate to accomplish the drainage of Washington by a combination of water-power and steam-power. He says :

"The mode is as follows: To continue the B-street sewer to James' Creek, and there construct a capacious basin, into which the drainage of the city would flow actively, the water in the basin to be pumped into the James'-Creek canal. By keeping the water in the reservoir low, the drainage would flow with great force into it, thus perfecting the drainage of the city by draining the several sewers, including the B-street sewer, to their bottom. A sluice upon the B street sewer at Seventeenth street would let in a sufficient supply of water for sanitary purposes, and it would keep out the tide and the freshets. A stream, controlled as to quantity by the sluice, would flow with force from the Potomac through the B-street sewer, or to the basin, removing all impurities and stagnant water from the sewer. The pressure of the Potomac would drive water with great force into the bottom of the sewer. The B-street sewer thus drained to its bottom, the many sewers which are tributary to it would act well, and the sanitary condition of Washington would be marvelously benefited. The Potomac could thus be controlled and used for the sanitary improvement of the city. The line of the B-street sewer to the basin would be by way of Missouri avenue—its

present line—to Third street, and down Third street to the cistern, the north end of which would be nearly parallel with the northern limits of the Arsenal grounds. The Third street section would be new. The sewer would be entirely independent of and separate from the Tiber-Creek sewer and the James'-Creek canal. It is the Potomac on the west—raised by the impediment to its flow caused by the Long Bridge—and the Tiber-Creek sewer on the east that inundates the business portion, the centre of the city, in times of freshets, destroying thousands of dollars' worth of property annually, and periodically deranging the entire sanitary condition of Washington. The Potomac under control—as I propose—and the Tiber-Creek sewer cut off, the tides and the freshets would be fully under control. James' Creek presents extraordinary advantages for the construction of the proposed basin. The basin is two-thirds made already. The land on the east and the west sides of the creek form two-thirds of the proposed capacious cistern. By putting a dam across the mouth of the creek—the water is not deep—and another in the James'-Creek canal at the north end of the Arsenal grounds, the basin would be substantially made. The James'-creek canal, at the point where the dam would be made, could readily be turned across Buzzard's Point to a convenient inlet which is at the other side of the Point. The distance is only about three hundred yards; therefore, the expense of changing the line of the canal would be small, considering the end to be accomplished. The proposed location of the basin is most desirable. It is near the line of the sewer, and it would not present the least inconvenience by land or water. It could be made as large as a small lake without injuring a dollar's worth of property. The pumping works could, with great convenience, be constructed at the north end of the basin, and the water could be pumped into the James'-Creek canal, which would be removed only the space of the dam from the cistern. To pump into the canal would be the same as to pump into the Potomac, as the water-level in the one and the other is the same.

“The entire surroundings are most favorable to the carrying out of the plan. It would be well to put the bed of the Third-street sewer about one foot below the level of the bed of the Missouri-avenue sewer. This would accelerate the flow on the entire line of the B-street sewer; such would be the effect of the one-foot drop; and if, in future, the B-street sewer would be reconstructed the one foot would afford it a beneficial fall. The fall of the water into the basin would constitute a power. Wheels erected at the points where the water would enter the reservoir would be propelled by it; all the water that would enter the basin would act upon the wheels; which, aided by steam-pumps, would pump the water out of the reservoir into the canal. The pumps could be constructed so as to have deliveries for low and high water. A sluice upon the sewer near the basin would cause all flows above the level of the Potomac to pass into the canal. An outlet for that purpose would be constructed. At this outlet there would be a gate which would keep out the tides and freshets. The keeping out of the tides and the freshets would be a great sanitary measure. About one hundred yards from the reservoir the sewer would be divided into two open races. In these traps would be formed, by digging, a space in each race about three feet below the regular level of the race; these traps would be about 200 feet long. All solid substances would lodge in these traps. When necessary to clean one of them, the flow could be directed through the other race. Then the manure in the race could be shoveled out conveniently and boated off. In this way the Potomac would be freed from many impurities, and the channel of the river would not be filled up. Besides, the manure would yield a large revenue for fertilizing purposes. It would thus be collected in one place, outside of the city, and the nuisances heretofore suffered, and the expense incurred by cleaning out sewers and traps by the slow process of bucketing would be discontinued. The sale of the fertilizer would more than cover the expense of working the machinery of the drainage. Therefore the drainage of the city—complete as it would be—would not be a tax upon the property of Washington. By the capacious basin and the pumping machinery, all floods and freshets could be fully and readily controlled. In times of floods both water-wheels could be worked. Thus, the freshets would dispose of themselves. One of the water-wheels, intended especially for freshets, would be of great capacity, and the pumps attached to it would be correspondingly powerful. By keeping the basin pumped out, it would form a receptacle for millions of gallons of water. This would afford a margin to the pumps in times of freshets. In a word, a portion of a freshet could be practically pumped out before its occurrence; that is, the receptacle formed for it would be equivalent to this: The basin kept low would be synonymous to lowering the Potomac, so far as the drainage of the city is concerned; and an achievement many times greater than the raising of Pennsylvania avenue and all the low sections of the city, both in North and South Washington, would be accomplished, and at less than one eighth of one per cent. of the expense; and the drainage of the city would be perfected for all time. The tides and the freshets would be fully controlled, and their hurtful consequences—the driving of inexpressibly loathsome matter into many of the stores, residences, and streets, contaminating the atmosphere of the entire city—would not longer be felt.”

We next invite attention to the suggestion that some modification of the plan proposed by Lieut.-Col. Geo. W. Hughes, in 1851, for supplying Washington with water for general purposes may be made available for effecting the desirable improvement of our sewerage. That plan was "to erect a dam across Rock Creek at a point near the southern boundary of Mr. Clagget's farm, * * * 20 feet high, so arranged as to draw off the water five feet below the crest of the dam, and to conduct it through an arched oval culvert of *three* by *four* feet interior diameter on a slope of one foot to the mile, * * * to a receiving reservoir on Meridian Hill."

The details of this plan may be found in a report from the Secretary of War, which was referred by the Senate to the Committee on the District of Columbia on the 27th of January, 1851.

In this connection it is proper to invite particular attention to the plan outlined by Dr. Verdi, as follows, in his last Report as President of this Board :

"To cure this terrible defect the construction of an intercepting sewer has become indispensable. This sewer should be of proper proportions and strength, and commence in the neighborhood of Twenty-fourth street N. W., gradually descending eastward to such a point near the Navy-yard as is practicable. If possible, it should cross the stream at a point near Uniontown, whence it should be pumped into a canal leading four or five miles away from the city.

"A work of this character would forever relieve the Capital from any danger from that source.

"This is the general idea of the intercepting sewer needed, but it may be modified by plans of more practical character and probably of less expensive proportions.

"At any rate, let our sewers be disconnected from the Potomac, except as to the emptying of their contents, and one of our greatest nuisances will be removed.

"This great work might be considered in connection with proposed plans of improving our water frontage, and the reclaiming of the many acres of marshy lands. One side of the sea-wall proposed to confine the flow of water of the Potomac on the north side of the river might be used as one side of the proposed sewer, thus greatly reducing the expense.

"I know that this proposition may startle the economist on account of the expense, but other governments have done no less for their capitals; nay, they have done an hundred fold more."

In reviewing the various plans, of which we have collated the outlines, we feel bound to accept the opinion of Lieut. Hoxie as to the plan of Major Randolph. That plan appears to us feasible; and we agree with Lieut. Hoxie that it will accomplish all that it proposes. But does it propose enough?

As a measure for immediate relief, it seems to have great merit, and it may be made a part of a judicious plan for permanent relief; but we cannot think that it alone can give the full and permanent relief that is so much to be desired. Probably a combination of it, or of some part of it, with some modification of the plan proposed in 1851 by Lieut.-Col. Hughes, as already indicated, may accomplish all that is to be desired.

It may be, also, that a combination of some such modification with Dr. Verdi's plan may be competent to effect the desirable improvement of our sewerage.

But we can hardly feel warranted in saying anything which could be fairly taken as an indication that we are entirely satisfied that any one of the plans to which we have respectfully invited your attention leaves nothing to be desired.

It seems to us that, sooner or later, a comprehensive plan must be adopted; and we respectfully and earnestly suggest that nothing should be done at present which can be reasonably expected either to greatly delay, or to render materially more difficult, or to make materially more expensive, such a comprehensive plan as may be found to be dictated by a wise consideration of our permanent interests in point of health and comfort.

